

An Optimal Load Balancing Technique for Cloud Computing Environment using Bat Algorithm

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Abstract

Background/Objectives: In this research, load balancing algorithm based on Bat Algorithm is implemented to achieve the goals of load balancer. **Methods/Statistical Analysis:** The proposed algorithm is implemented using "Parallel Processing toolbox" in Mat lab and the results are compared with other techniques, namely, Round Robin and Fuzzy GSO. **Findings:** Results are discussed in the context of response time and based on the number of tasks. While balancing the load among the virtual machines, job migration to another virtual machine will affect the response time. In future, further work is on the development of job migration algorithm.

Keywords: BAT Algorithm, Cloud Computing, Load Balancing

1. Introduction

Cloud Computing allows the user to access the resources, like, computing power, storage, applications and services from the shared pool with minimal interaction between Cloud User, Cloud Broker and Service Provider. It not only offers on-demand services to the users, but also provides broad network access, resource pooling, along with elasticity. NIST has referred major components of Cloud Architecture as "Cloud Actors". Author of¹ described the referral model of Cloud Computing, having two types of Actors i.e. Internal Actor and External Actor. These actors are: Cloud Consumer, Cloud Provider, Cloud Auditor, Cloud Broker and Cloud Carrier. The Cloud Consumer is the end user or organization who needs the Cloud Service. The Cloud Consumer gets the services from the Cloud Provider directly or through the Cloud Brokers. Cloud Auditor is a separate party who analyzes the services offered by the Cloud Providers and gives ranking to the Cloud Providers. The ranking assessment is given based on the implementation security, privacy impact and performance of the service. Cloud Providers are responsible for offering cloud services to the consumer.

The cloud providers are providing the services according to the user's requests and also manage the security issues. Cloud Brokers are intermediate actors between the Cloud Consumer and service provider. When the consumer requires multiple services from different providers, it is too complex to integrate all the services, so at that time, Brokers act as the single point of interaction between users and service providers, to manage multiple services in efficient manner. The cloud environment consists of 3 types of deployment models, i.e. Software as a Service, Platform as a Service, and Infrastructure as a Service. Various research fields of Cloud Computing environment are explored by researchers, in order to improve the performance of the existing techniques, used either for virtualization or for managing huge amount of data or for providing secure access to the consumers or for balancing the load of virtual machines. In this research work, main objective is to implement a new technique of load balancing in cloud computing environment. Load balancing plays a vital role in cloud computing to allocate load to the cloud servers. The major goal of the load balancing is to keep all the servers busy and to make the full utilization of resources in the efficient manner. A vast number

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of load balancing algorithms have been proposed and implemented to achieve better results. While developing an efficient load balancing algorithm, one must consider following parameters, including type of service, requirements of the load and the processor capacity. Basically, load balancing algorithms are either categorized as Static or Dynamic. In static load balancing algorithm, all functions are pre-defined and it also considers the prior state of the system, whereas in dynamic, prior knowledge is not considered. Various Scheduling techniques and algorithms used for load balancing in Cloud Computing¹ are depicted in Figure 1.

In² proposed an ACO based load balancing approach, based on the behavior of ants. The ants find an optimal solution by comparing their pheromone value with others. Initially, the proposed algorithm works in First Come First Service to allocate the tasks to the virtual machines. If all the virtual machines are in busy state, then multiple artificial ants are created with same pheromone value and tasks are distributed to the virtual machines, using Ant Colony Optimization. The ants visit all the virtual machines by comparing their pheromone value with their neighbor. Once all the ants have traversed every virtual machine, virtual machines are tabulated by their current work load and their processing speed and accordingly tasks are allocated to these machines. In this approach much process delay occurred because tasks have to wait until the ants finish their search in all virtual machines.

In² used the concept of Fuzzy Logic and proposed a load balancing technique. The implemented technique works in two phases: at Node Level and at Cluster Level. At Node level, Local Manager is used to collect and maintain the information and at Cluster level, Global Manager maintains the status of each cluster. The global and local manager collects the information from the nodes and clusters, at some specified time intervals. At each interval, global manager sends the current status to the Grid manager. Based upon the global manager information, the Grid Manager ranks the cluster's status. Once ranking is done, all the incoming processes/tasks/jobs get the service based upon their workload and node's rank. This method gives fast response and efficient VM selection. But proposed algorithm works on the principle of static load balancing and job scheduling because fuzzy logic system executes pre-defined instructions.

In³ reviewed the advancements introduced in newly developed meta-heuristic approach, namely, Bat algorithm for achieving optimization.

In⁴ an algorithm is proposed by the combination of fuzzy logic method and Glow Worm Swarm Optimization (GSO) method. When the incoming task arrives in a fixed rate, Fuzzy Logic is used for job allocation to virtual machines, otherwise GSO approach is used. In⁴ authors has proposed a Hybrid approach for the load balancing. This approach maintains a Hash table for allocating job and maintaining processor status. Depending upon the hash table entries, task is allocated to the processor. The efficiency of the algorithm lies on the hash table creation and maintenance strategy. The hash table creation is not an easy one; once error occurred in the hash table then the entire system fails. In⁵ authors has proposed multicasting approach for handling the requests for cloud services in Cloud Computing environment. The author of⁶ proposed an algorithm for load balancing of virtual machines, based on Particle Swarm Optimization (PSO). This algorithm optimizes the process execution time in context of process running time and resource utilization. Over the standard PSO, self-adaptation technique is applied, to achieve better utilization of the virtual machine resources and reduce the execution time. This implementation has heavy bandwidth restriction and job decomposition problem placed. In⁷ various nature inspired optimization approaches are reviewed. In^{8,9} latest load balancing techniques are reviewed. In¹⁰ for solving continuous optimization problems, Improved Bat Algorithm (IBA) is proposed by the author. In¹¹ many variants of bat algorithm are reviewed

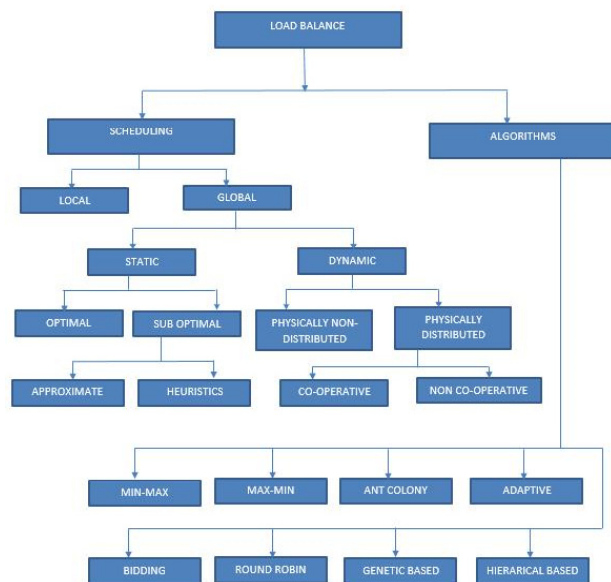


Figure 1. Load Balancing Algorithms.

by the author and conclusion is drawn regarding the applicability of this meta-heuristic technique in different application areas.

2. BAT Algorithm

BAT Algorithm is based on bats echolocation behavior, proposed¹². The bats fly unpredictably by varying the velocity, pulse emission rate, position, frequency and loudness while chasing its prey. When the bat attempts to discover its prey, they'll modify their position, velocity and rate of pulse emission based on the distance between the prey and itself. The adjustment of velocities and positions of bats incorporates like a PSO algorithmic system. In⁴ described the complete details on variants of Bat Algorithm and recent Load balancing techniques in Cloud Computing. In this research work, an algorithm, based on Bat Algorithm, for load balancing is proposed for Cloud Computing environment and described in next section.

3. Proposed Algorithm

In Bat algorithm, optimum and finest result can be obtained, by executing the algorithm over multiple iterations. In this work, Bat algorithm is used to find the optimal server among all the available servers, for the execution of incoming job¹³⁻¹⁵. When any task arrives in the job pool, load balancer will invoke the bat algorithm to find the best server which suits to the requirement of incoming task. The bat algorithm considers job type and resource required, while selecting the optimal virtual machine for execution of task. Once an appropriate server is selected, it assigns the load to the current server. If the load is higher than the load of all other servers, then the task is distributed to more than one server. The job allocation is done in the following manner. Consider there are 'n' number of Virtual Machines $[VM_1, VM_2, \dots, VM_n]$. At time T_1 if task ' P_1 ' is assigned to machine VM_1 then at another time interval T_2 , task P_2 will be allocated to any Virtual Machine, i.e. VM_i except VM_1 even if VM_1 is satisfying the task P_2 requirements. Because objective is to make full utilization of available resources and keep all the systems busy and avoiding the over loading of a single machine. The following figure 2 describes the flow of proposed system.

4. Result and Analysis

The proposed algorithm is implemented in MATLAB simulator tool and jobs are assigned using Parallel Cluster tool box. Figure 3 and Figure 4 describes the response time of proposed algorithm with Round Robin and Fuzzy based GSO algorithm. Figure 5 represents the degree of load balancing according to the total number of tasks for proposed algorithm.

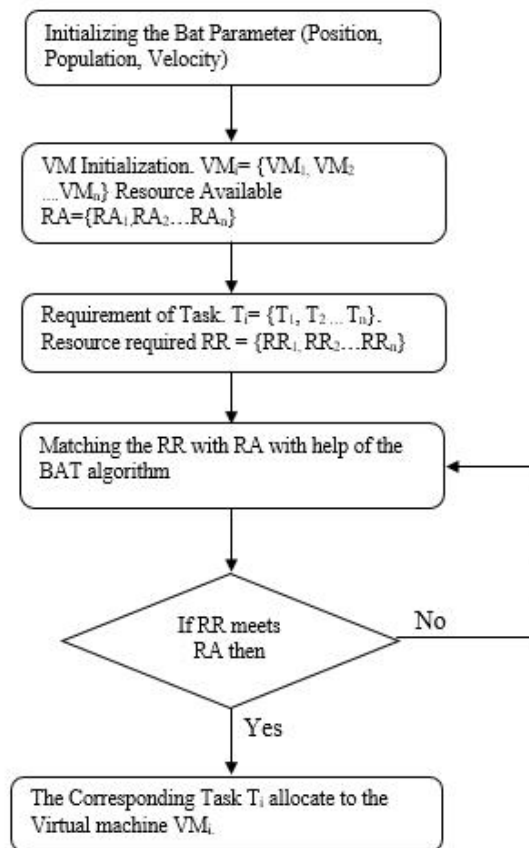


Figure 2. Methodology for balancing the load.

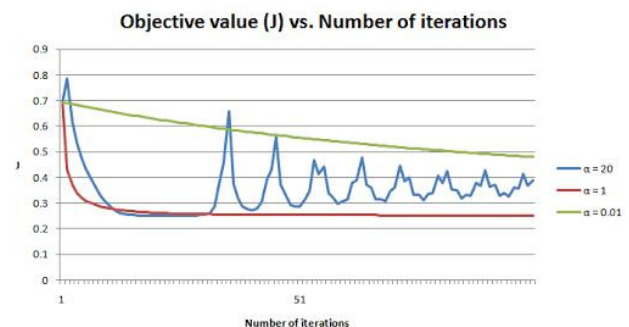


Figure 3. Number of Iterations vs. Objective Value.

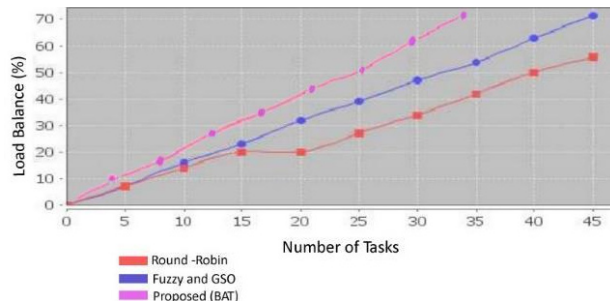


Figure 4. Load Balancing w.r.t Number of Tasks.

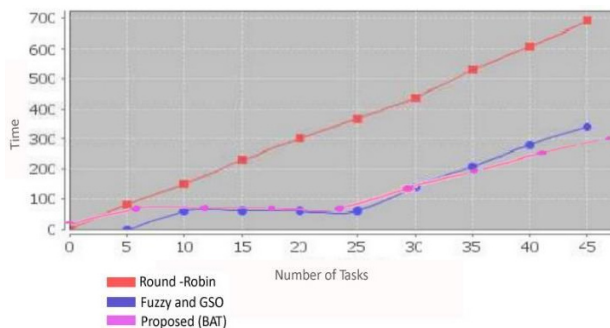


Figure 5. Comparison with other load balancing algorithms.

5. Conclusion

Bat algorithm based load balancing technique has been implemented for minimizing the response time and performs load balancing without causing any delay. The bat algorithm helps in balancing the load effectively over various virtual machines.

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